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Valuation of wildlife populations above survival

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Abstract Biodiversity valuation studies often address the willingness to pay (WTP) for species survival. Many policy initiatives, however, target more generally the population levels of wildlife. This study investigated the empirical question of WTP for enhancing species populations also beyond the survival level. Respondents' WTP for increases in population levels of endangered species as well as of general wildlife in three habitats were evaluated in a choice experiment, by trading off against income tax and restrictions in recreational access. Any person may have several motives for deriving value from enhanced wildlife populations, and variation in values were analysed in a Latent Class model. We document considerable discrete variations in WTP and respondents fall into several distinct groups. The first group express a significant WTP for saving endangered species only and has no positive WTP for higher population levels, indicating that existence values dominate their WTP. The second group put emphasis on wildlife, but with equal weight attached to moderate and high increases in population for 'Endangered' as well as 'General' wildlife. Thus, they appear insensitive to scope. The pattern suggests that WTP may be affected by warm glow or deontological motivations. The third group reveal significant WTP, but for at least one of the wildlife attributes they prefer moderate increases over high. This could be due to moral motivations or reflect provision cost concerns. Our findings point to the caution needed when using results from studies focusing on species survival in valuing broader initiatives.

Keywords Choice experiment · Existence value · Latent class · Moral satisfaction
Self-image · Warm glow

Abbreviations
CE Choice experiment
CV Contingent valuation
WTP Willingness to pay

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Introduction

Since the Convention on Biological Diversity was signed by a large number of countries following the Rio Summit in 1992, policy schemes and instruments have been implemented in an effort to protect biodiversity, a commitment reinforced at the Nagoya COP 10 (CBD 2010). As biodiversity refers to the variety among living organisms (Levin 2000) it often leads to a particular focus on species preservation. Any economic resources redistributed to species preservation come at a cost. As resources are limited, these costs must be compared to the benefits, and from a welfare economic point of view it is therefore important to assess the value of biodiversity preservation. This is a challenge for environmental valuation.

While valuation studies have mostly focused on the difficult question of preserving species versus not preserving them, this study investigated how people value population changes also above that required for survival. We developed a choice experiment (CE), where respondents were faced with choices involving efforts to increase the populations of endangered as well as of general wildlife, for three habitat categories. In addition, choices included various levels of restricted recreational access to the habitats, to the benefit of wildlife. Thus, respondents were offered options to choose between population levels, also above that needed to secure the survival of a species, and weighed this against restricted access and an income tax increase. This combination is new to the literature and designed to investigate further the willingness to pay (WTP) for population increases beyond that needed for species survival.

The paper is organised as follows. In "Literature and hypotheses" section we outline the relevant empirical and theoretical literature and set up the hypotheses addressed in our analyses. "Method" section describes the CE method, and "Survey design and data" section the data collection and design of the questionnaire. Results are presented in "Results" section and discussed in "Discussion" section. Conclusion makes up "Conclusion" section.

Literature and hypotheses

Valuing species preservation or population levels

Species can be valued indirectly by focusing on the preservation or expansion of habitats, landscapes or ecosystem functions supporting biodiversity. Valuation is, however, typically done in terms of biodiversity broadly and the proposed changes are often formulated rather general, for example see Jacobsen and Thorsen (2010); Czajkowski and Hanley (2009); Czajkowski et al. (2009) or Chen and Jim (2010).

Another strand of literature addresses the issue of species preservation as a proxy for biodiversity, partly due the complexity of the biodiversity concept for people (Christie et al. 2006). Typically, such studies state their questions to respondents in the form of preservation or not of one or more named species and pay little, if any, attention to the population levels beyond survival needs. Examples are White et al. (1997); Giraud et al. (1999); Jakobsson and Dragun (2001); Veisten et al. (2004); Tisdell et al. (2004, 2005, 2007); Jacobsen et al. (2008). Other studies again use simply the number of preserved species, with no particular focus on the specific species (e.g. Giraud et al. 1999; Lehtonen et al. 2003; Do and Bennett 2008; Black et al. 2010).

While focusing on one or more species undoubtedly eases the communication, it has flaws. Preserving one or several species cannot be seen separately from preserving ecosystems, and it is often unclear if this is accounted for by respondents (Czajkowski et al. 2009). Furthermore, many nature preservation projects are focused on increasing the population of a species and not only securing its survival. This raises the issue of how people's WTP for species conservation measures will be affected if valuation questions are not phrased as a gunpoint type of 'preserve-or-not' questions, but *also* address population increases beyond survival levels.

The relatively few studies that have dealt with this question often operate with species, where increasing population levels can be an obvious 'bad'. Examples include Boman and Bostedt (1999) on the population of wolves in Sweden, Jorgenson et al. (2001) on wolves in Wisconsin, and Johansson (1999) on population levels of wild elephants, see also Bandara and Tisdell (2003). In some of these studies, WTP levels off or even declines for sufficiently large population increases.

Only a few studies have touched upon the aspects of species valuation where population increase is not seen as a bad thing. One of these is a CV study by Fredman (1995), who finds that people holding existence value as the main motive for contributing have a negative marginal WTP for an increase in the population density of the white-backed woodpecker, corresponding to a classification change from 'rare' to 'common'. Among different reasons for preserving the woodpecker, the reason "All species have a right to exist" is given first priority, and Fredman interprets the results as evidence of existence values. Another study is Adamowicz et al. (1998), which used a CE to value the population of mountain caribou. The population attribute had four levels, ranging from 50 to 1,600 animals, and the study found that WTP for population increases was increasing until a population of 600. Hereafter the WTP declined considerably. The population size of 600 caribous equals the number that respondents were told was the minimum required for a viable population. Hanley et al. (2003) report no WTP for goose population increases for the general public, and even a negative WTP for large increases for local residents, which may indicate that these residents consider large goose populations a nuisance. In a CV study, Loureiro and Ojea (2008) find almost identical WTP for different population increases of the guillemot, except when they explain that it is common elsewhere; then WTP decreases with increasing population levels. Do and Bennett (2008) find a positive WTP for increasing populations of a crane species, but do not report for different population levels.

Possible patterns and motivations for WTP for population increases beyond survival

Several of the above studies, focusing on preserving several endangered or rare species, have documented increasing WTP for increasing levels of preservation (e.g. Czajkowski et al. 2009; Horne et al. 2005; Jacobsen et al. 2008; Jacobsen and Thorsen 2010). For many environmental goods we would expect WTP to increase with increased provision offers, even if at a decreasing rate. This is often tested for by scope tests (see, e.g. Heberlein et al. 2005), and in several of the mentioned studies, preferences pass such tests.

Extending these results from preservation of one or more species to population levels more broadly, one could form the hypothesis that as wildlife populations increase, so will the utility derived by respondents from this wildlife, e.g. in terms of recreational experiences. One may expect this to be true in particular where use values dominate, e.g. because increasing populations increases the probability of spotting the species in the wild (e.g. Bosetti and Pearce 2003). However, as Freeman (2003) argues, the changes in quantities that respondents are expected to be sensitive to, have to be changes relevant to them. There may be several reasons why population changes are not equally relevant or relevant to all people.

First, while increasing wildlife populations may involve significant use values to some, others may mainly focus on non-use values (Fredman 1995). Such values are likely to play a relatively larger role for biodiversity conservation than for many other environmental goods. If it is mainly the continued existence of a species that represents a value to people, it is not obvious that their WTP would be sensitive to population increases beyond preservation levels. Karlsson and Sjöström (2008) show that in particular urban people cite passive use or existence value arguments as motivations for expressing support for the conservation of large carnivores in Sweden.

Secondly, and much debated (see, e.g. Kahnemann and Knetsch 1992), is the 'warm glow of giving' (Andreoni 1989, 1990), which has been singled out as a possible private motivation for support to public goods in general. Respondents may derive a private (though possibly cause dependent) utility from the mere act of supporting the preservation of endangered species or enhancing wildlife populations in general. While this is a valid part of respondent utility, it is not obvious that such a motivation will relate to the scope of the good in question, here the population increase.

Thirdly, species preservation is loaded with tough ethical and moral questions. It is possible that some respondents can or will not make reliable trade-offs between the survival of one or more species and, e.g. a tax payment. Albeit being hypothetical, this kind of valuation question can be considered posed at a sort of moral or ethical 'gunpoint' which may prompt different reactions. Some respondents may have deontological stances, which affect the way they perform the trade-offs implied by the valuation exercise (Menzel and Wiek 2009). Or respondents may choose to express preferences that reflect their ideas of how to behave as an environmentally responsible person, rather than their private relation to the good in question. Thus, they express civic rather than selfish preferences (Nyborg 2000) and support some level of increases, even if they privately experience a negative utility of population increases, e.g. are uncomfortable with recreational wildlife experiences. Alternatively, they could be motivated by moral considerations of what the socially optimal effort would be, e.g. taking into account other tasks and responsibilities of society (Brekke et al. 2003). Such motivations could result in many different patterns of WTP for increasing wildlife populations, including patterns not consistent with standard expectations of scope sensitivity.

Formalising possible hypotheses about WTP for population increases

In this study we valued improvements for wildlife. Respondents were faced with two groupings of wildlife. For the group 'Endangered', potential population increases included two levels, in addition to the status quo 'Endangered': A level of 'Rare, but not endangered', being just sufficient for survival, and a higher level denoted as 'Common'. For the group 'General Wildlife', population levels included status quo, +25 and +50%, all of which were beyond species survival levels. For an overview and details of the basis for this selection, see "Survey design and data" section and Table 1.

Based on the above literature, we formulated three hypotheses reflecting possible dominant motivations for respondents' WTP. They are rather strict interpretations of different utility based motivations for WTP for biodiversity preservation. The hypotheses are expressed in terms of implications for WTP's dependence on population increases. It is quite likely that any respondent could hold preferences reflected in more of these

Table 1 Attributes and levels in the CE questionnaire

Attribute	Level
Access Access to habitat	Unrestricted access (status quo)
	Reduced access (no access in 25% of all of the specific habitat from April to October)
	No access (no access in 25% of all of the specific habitat all year)
Endangered Increases in populations of a endangered species related to the habitat	Endangered with extinction (status quo)
	Rare, but not endangered with extinction
	Common
General wildlife Increases in populations of general wildlife in the specific habitat	Population as of today (status quo)
	Population increase by 25%
	Population increase by 50%
Cost Annual tax increase per household per year	0 (status quo)
	DKK 100
	DKK 250
	DKK 500
	DKK 1,000
	DKK 2,000

DKK 100 equates ~EUR 13

hypotheses. Thus, they are not mutually exclusive, and also we do not claim the set to be exhaustive. Nevertheless, they all link up to important aspects of the economic valuation of biodiversity discussed in the literature.

Hypothesis H1: Utility, and hence WTP, is increasing with increasing population size, potentially at a decreasing rate.

The implication for WTP for the attribute 'Endangered' is:

$$\mathrm{WTP}_{\mathrm{Endangered}\rightarrow\mathrm{Rare}} < \mathrm{WTP}_{\mathrm{Endangered}\rightarrow\mathrm{Common}} \tag{1}$$

And likewise for 'General wildlife':

$$\mathrm{WTP}_{\mathrm{General\ wildlife}\ +25\%} < \mathrm{WTP}_{\mathrm{General\ wildlife}+50\%} \tag{2}$$

this is a standard scope hypothesis and thus draws on standard economic assumptions about non-satiation and on the assumption that positive population related utility components will be reflected in WTP. This could, e.g. be related to recreational experiences.

Hypothesis H2: Securing the existence of species is what matters to utility and hence WTP. Therefore, people are only willing to pay for population changes that lift species above the minimum viable population.

The implication for WTP for the attribute 'Endangered' is:

$$\mathrm{WTP}_{\mathrm{Endangered}\rightarrow\mathrm{Rare}} = WTP_{\mathrm{Endangered}\rightarrow\mathrm{Common}} \tag{3}$$

and for 'General wildlife' the implication is:

$$\mathrm{WTP}_{\text{General wildlife }+25\%} = \mathrm{WTP}_{\text{General wildlife}+50\%} = 0 \tag{4}$$

under the assumption that existence value dominates utility gains, WTP should be significant for securing endangered species to the level of 'Rare, but not endangered'. If only existence value matters, there is no reason for people to pay more for increases above that, including paying anything for increases in 'General wildlife' with no direct gains in existence values.

Hypothesis H3: WTP for increasing wildlife populations is driven by warm glow or a donation will to the specific cause, but with no attention to the provision level.

The implication for WTP for the attribute 'Endangered' is as above in Eq. 3, whereas the implication for the 'General wildlife' now is:

$$\mathrm{WTP}_{\text{General Wildlife }+25\%} = \mathrm{WTP}_{\text{General Wildlife }+50\%} \neq 0 \tag{5}$$

thus, under this hypothesis, people could derive a utility, also likely a warm glow utility, from supporting these purposes. Note that we assume that the warm glow relates to the purpose, not to the size of the donation. People are still assumed to dislike parting with money.

Method

The CE method was originally developed for market analysis (Louviere et al. 2000) and it relies on McFadden's (1974) random utility model, where the utility of a good is described as a function of its attributes and people choose among complex goods by evaluating their attributes. The random utility model is the fundament for estimation and can formally be described as:

$$U_{ij} = V_{ij}\left(y_i - t_j, x_j, z_i\right) + \varepsilon_{ij} \tag{6}$$

the term U_{ij} is the i'th individual's utility of paying t_j out of individual income y_i for the good described by alternative j. V_{ij} is a deterministic term depending on income, the alternatives' attributes $x_{j,}$ and the individual's characteristics, z_i. Note that this general formulation also allows for utility components like warm glow effects, moral satisfaction, and public good aspects, etc. to the extent that these can be captured by characteristics of the individual, the good or other variables included. The term ε_{ij} is stochastic in the sense that its variation cannot be observed by the analyst. Assuming that U is linear in its arguments and collecting all the arguments in the vector x_{ki} for given alternative k and individual i, we can write $U_{ki} = \beta' x_{ki}$, where β is a vector of parameters. Assuming that ε_{ki} is IID extreme value distributed, the probability of an individual i choosing alternative k over a set of alternatives J is given by the Conditional Logit model:

$$\Pr_i(k) = \frac{\exp(\mu\beta' x_{ji})}{\sum_j^J \exp(\mu\beta' x_{ji})} \tag{7}$$

where μ is a scale parameter often assumed to equal 1.

As we were interested in identifying potentially systematic variations in the preferences of different groups rather than of the population as a whole, we chose a Latent Class (LC) model to take into account preference heterogeneity rather than, e.g. a Random Parameter

Logit. The LC model assumes that the population consists of a finite number of segments with substantially different preference structures. It simultaneously classifies respondents into segments and identifies their utility parameters contingent on their class membership probability (Train 2003). We assume that the vector β in Eq. 7 is not specific to an individual but instead to one of the segments S, and that individual i belongs to segment s ($s = 1,\ldots, S$). The specification can be generalised to allow for repeated choices by the same respondent, i.e. a panel structure, if the utility coefficient varies over people but is constant over choice situation n. Following a similar approach as, e.g. Ruto et al. (2008) the utility parameter β and the scale parameter μ_s become segment-specific, and the joint probability of a set of choices n, given the individual belongs to segment s, becomes:

$$(\Pr(ni|s) = \prod_{n(i)}^{N} \frac{\exp(\mu_s \beta_s' x_k)}{\sum_{j=1}^{J} \exp(\mu_s \beta_s' x_j)} \tag{8}$$

assuming the error term to be independently distributed across individuals and segments with a Type I extreme value distribution and a scale factor α, the probability of an individual's membership of segment s is represented by:

$$\left(\Pr_{is}\right) = \frac{\exp(\alpha\lambda_s)}{\sum_{s=1}^{S} \exp(\alpha\lambda_s)} \tag{9}$$

here λ_s is the segment specific parameter vector for class probability. It is possible to explicitly include psychometric constructs and socioeconomic characteristics to model systematic patterns in class probabilities. Apart from that, we follow the approach of Boxall and Adamowicz (2002). Assuming the scale factor to be equal to one, the probability that a randomly chosen individual i chooses k conditional on being in segment s ($\Pr_{ik|s}$) can be expressed as the following product of the probabilities defined in Eqs. 8 and 9:

$$\left(\Pr_{ik|s}\right) = \sum_{s=1}^{S} \left[\frac{\exp(\alpha\lambda_s)}{\sum_{s=1}^{S} \exp(\alpha\lambda_s)} \right] \left[\prod_{n(i)}^{N} \frac{\exp(\beta_s' x_k)}{\sum_{i=1}^{J} \exp(\beta_s' x_j)} \right]. \tag{10}$$

Survey design and data

A questionnaire was designed on the basis of discussions with experts in wildlife and tested in focus groups of diverse people as well as in individual interviews. A postal questionnaire was used that focused on access to and wildlife protection in three widespread Danish habitats: forests, open fields, and along lakes and streams. Along with the questionnaire, respondents were given an information sheet describing current status of wildlife and access (see "Appendix" section). The first part of the questionnaire concerned respondents' attitudes to nature and wildlife and their recreational use and wildlife experiences. This was followed by the CE part, and the final part concerned debriefing and respondents' socioeconomic characteristics.

The CE included 2 × 6 choice sets, where respondents were distributed to two out of three habitats. The same design was used for the three habitats, but allocated to respondents by a cyclic design to even out order and combination effects. Across blocks, response rates were similar. Each choice set consisted of three alternatives, the first alternative always representing status quo. The attributes describing each alternative included (i) initiatives to increase the populations of wildlife in general, (ii) initiatives to increase the populations of endangered wildlife, and (iii) various reductions in access to the habitats for the public in order to improve living conditions for wildlife. The latter was included in order to make the scenarios more realistic as access restrictions to nature areas is an often debated as a means for improving conditions for wildlife. The policy realism of this also enhances the incentive compatibility of the choice exercise as access restrictions are a likely policy tool, and as it involves use values which most people have much experience with. Focus group interviews showed no sign of mistrust or disbelief concerning the attribute levels, including the potential for actually increasing wildlife populations. Rather, focus group members stressed the importance of society dealing with the challenges of species protection, and the discussion also related to ongoing debates about the prioritisation between A and B nature, corresponding to the targeted efforts for special, often threatened habitats and species relative to efforts targeted more broadly. This distinction is also common in, e.g. municipalities' nature management plans. Respondents were explained that the increased expenses due to improvements would be financed by income taxes. Today, all similar public actions are funded in this way, giving credibility to the choice of payment vehicle in this specific context. The full set of attributes and levels is described in Table 1.

A complete factorial design would involve 162 combinations of alternatives for each habitat. However, some choice sets were removed as they were believed to add too little information. Thus, we excluded choice sets where (i) all wildlife and access attributes were identical to the status quo for one of the alternatives (which would then never be chosen), (ii) one of the alternatives had both wildlife attributes identical to the status quo, but both access and price were different (which would imply paying for reduced access only), (iii) both wildlife attributes were higher and both price and access lower for one of the alternatives than for the other. Apart from this, a number of other choice sets with a potentially dominant alternative were kept in the final design, e.g. respondents were offered choice sets where higher wildlife populations came at lower cost than in the competing alternative. Also alternatives with a zero price were considered. From this potential set, we used a modified Fedorov candidate set search algorithm (Kuhfeld 2004) to generate a design where d-efficiency was targeted for a multinomial logit analysis. Then choice sets were blocked into groups of six. The resulting (ex ante) d-error for this design was 0.003168 evaluated without the status quo and 0.003692 with. The design, when evaluated ex post, had a d-error of 0.000834 when evaluated as a multinomial logit. See Ferrini and Scarpa (2007) for a discussion hereof.

The endangered species used for the questionnaire was Dormouse (*Muscardinus avellanarius*) for the forest, Barn owl (*Tyto alba*) for the field, and Otter (*Lutra lutra*) for the lakes and streams. Iconised representatives (cf. Jacobsen et al. 2008) of general wildlife were used comprising Hare (*Lepus capensis*), Great Crested Grebe (*Podiceps cristatus*), and Great Spotted Woodpecker (*Dendrocopos major*). The species may not have equal appeal in terms of charisma, but all of them are known by most people.

In Denmark, recreational access to land is regulated by law and, in particular on private land, there are some restrictions as to what kind of recreational activities the public are allowed. Ordinary recreational activities like walking and biking along paths etc. are allowed on most lands. Therefore, we expect respondents to react with demands of compensation for reductions in their access to habitats, even if explicitly motivated by concerns for wildlife protection, e.g. moderate reductions during the breeding season. Such reductions of access are commonly implemented in various specific localities, and this attribute thus adds plausibility to the overall case description.

The different versions of the questionnaire were randomized and sent to a representative sample of 1,800 people in Denmark in May 2005, and 862 questionnaires were answered and returned, which equals an overall response rate of almost 48%. A total of 460 of these concerned sub-samples which are not presented in the current paper. The relevant sample thus consists of 387 respondents. We identified 38 serial non-respondents, i.e. respondents who chose the status quo alternative in all 2×6 choice sets (von Haefen et al. 2005). As many as 17 of the serial non-respondents stated that the reason for only choosing status quo was a reluctance to pay more tax. We perceive this as protest behaviour and excluded these respondents from the sample. This results in 370 respondents answering 4,348 choice questions, as not all respondents completed all 12 choices.. The sample showed a slight overrepresentation of people with higher educations, higher income, and middle-aged (i.e. 35–65 years), but this is unlikely to have an effect on the pattern in the results we present below.[1]

Results

The main results are based on the estimation of the following utility function (without interaction effects):

$$U_{ij} = (\alpha_j + \beta_{1i}\text{Reduced\_Acces}_j + \beta_{2i}\text{No\_Access}_j + \beta_{3i}\text{Gen\_Wildlife25\%}_j \\ + \beta_{4i}\text{Gen\_Wildlife50\%}_j + \beta_{5i}\text{End\_Species\_Rare}_j + \beta_{6i}\text{End\_Species\_Common}_j \\ + \gamma_i t_j) + \varepsilon_{ij}$$

the data from the three different habitats were first analysed for systematic differences in preference patterns. We did so by applying the test suggested by Poe et al. (2005). We found that WTP measures related to the fields and meadows habitat were not significantly different from the results related to the lakes and streams habitat. Results from the forest habitat were significantly different from the fields and meadows habitat, but not from the lakes and streams habitat.[2] First, this was analysed by constructing a set of interactions between all attributes and the forest habitat. However, almost all turned out to be non-significant. Consequently, data are pooled in the present study. We did carry out the same analysis by excluding the forest habitat, and the results showed similar patterns as the ones presented.[3]

In LC models, the number of segments, S, is not given from the maximum likelihood maximisation from which the preference parameters are estimated. We therefore estimated a number of models with different number of segments and assessed standard information criteria, see Table 2.

Looking only at the different performance and information criteria, the models with five segments perform better than models with fewer segments. However, in both models with five segments we find a group including 5% or less of the underlying population, and in these segments most parameters are insignificant and provide little basis for interpretation. Thus, we follow Scarpa and Thiene (2005) who note that the number of segments must also

[1] Detailed information on representativity can be obtained from the authors upon request.

[2] The analyses are not reported here, but can be obtained from the authors upon request.

[3] Results from this split can be obtained from authors upon request.

Table 2 Statistics for evaluating models with different numbers of latent segments

Number of segments	Distribution of segments	Log likelihood	BIC (Bayesian information criteria)	AIC (Akaike information criteria)	R^2
2	0.40; 0.60	−3.245	1.525	150.063	0.321
3	0.24;0.29;0.47	−3.064	1.459	142.161	0.358
4	0.25;0.08;0.27;0.40	−2.984	1.440	138.904	0.375
5	0.23;0.04;0.22;0.21;0.30	−2.927	1.431	136.695	0.387

be based on the analyst's expert judgement on, e.g. significance of parameter estimates and the meaningfulness of the results, and chose to base our analysis on four segments in both models.

Preference space results

Table 3 shows the preference space results of estimating the LC models with four segments included. The size of each segment is also shown. Except for segment 2 all segments cover a considerable amount of respondents. It is seen that the estimated parameters show large differences in preferences between the four segments, but in all cases the price parameter is significant and negative, as expected. The pseudo-R^2 is close to 0.4, which is satisfying.

For the first segment the alternative specific constant (ASC) is insignificant. The constant captures preferences associated with the status quo situation, which is not described by the attributes. Apart from the price and ASC only the parameters for 'Reduced access' and 'Endangered wildlife-rare' are significant at the 5% level.

For segment 2, the tax parameter is quite small, but highly significant. The access attributes are significant, but not different from each other. Otherwise only the parameter for 'General wildlife +25%' is significant. Notice that the level for '+50%' is smaller and insignificant.

Segment 3 has an insignificant ASC. All other parameters are significant. Notice that for the wildlife attributes the middle population levels are significantly larger than the high attribute levels. The opposite is the case for the access attribute, where increasing restrictions reduce the parameter further.

Segment 4 has a significant and fairly large negative parameter for the ASC and the parameter for 'Reduced access' is insignificant, whereas the 'No access' parameter is negative and significant. All parameters for wildlife attributes are significant and positive. However, the parameters for 'Endangered wildlife-rare' is marginally, but not significantly lower, than 'Endangered wildlife-common'. For general wildlife, however, the parameter for +25% is significantly larger than that for +50%.

WTP measures in the Latent Class models

Estimating the WTP measures for the different attributes allows us to evaluate the results against the hypotheses formulated in "Literature and hypotheses" section. Table 4 shows the calculated WTP and corresponding 95% confidence intervals. We focus on the wildlife attributes in the following and evaluate our three hypotheses against the results across tables.

Table 3 The parameters of the Latent Class model

	Segment 1		Segment 2		Segment 3		Segment 4	
Segment size	0.252		0.08		0.266		0.402	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Price	−1.421***	0.206	−0.057***	0.010	−0.474***	0.025	−0.117***	0.005
Asc	0.483	0.298	−0.328	0.237	−0.059	0.153	−1.884***	0.140
Endangered wildlife-rare	0.613*	0.251	0.325	0.198	2.055***	0.137	1.537***	0.090
Endangered wildlife-common	0.464	0.271	−0.112	0.188	1.701***	0.112	1.661***	0.085
General wildlife +25%	0.056	0.273	0.769***	0.199	1.266***	0.140	0.991***	0.084
General wildlife +50%	−0.147	0.266	0.083	0.212	0.919***	0.117	0.668***	0.078
Reduced access on 25%	−1.211***	0.277	−1.221***	0.152	−0.309**	0.115	−0.058	0.069
No access on 25%	−0.536	0.314	−1.478***	0.183	−0.748***	0.132	−0.161*	0.076
Number of respondents	370							
Number of choice sets	4348							
Log likelihood	−2984							
McFadden Pseudo-R2	0.375							

Significance levels are *5%, **1%, and ***0.1%

Table 4 Estimated mean WTP (DKK/household/year) measures for the Latent Class model

	Segment 1		Segment 2		Segment 3		Segment 4	
Segment size	0.252		0.08		0.266		0.402	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Asc	34.00	22.11†	N/A	N/A	N/A	N/A	−1603.73	122.99***
Endangered wildlife-rare	43.12	18.08*	N/A	N/A	433.17	32.15***	1308.09	75.49***
Endangered wildlife-common	32.63	19.41†	N/A	N/A	358.62	25.40***	1413.63	82.74***
General wildlife +25%	N/A	N/A	1358.88	387.03***	267.00	29.25***	843.93	78.91***
General wildlife +50%	N/A	N/A	N/A	N/A	193.72	23.83***	568.57	66.81***
Reduced access on 25%	−85.21	22.76***	−2157.18	450.13***	−65.20	24.20**	N/A	N/A
No access on 25%	−37.70	22.84†	−2612.07	426.21***	−157.66	29.33***	−136.65	62.80*

Only WTP significant on at least 10% is shown in the Table: †10%, * 5%, ** 1%, and *** 0.1%

First of all, note that *none* of the segments provide clear support for H1. In none of the segments did we find a consistent and significant increase in WTP with population increases. While we find a positive WTP in some segments for increased population levels above current levels, there is no clear and consistent increase in WTP with increases from middle to high levels of both types of attributes. So overall we can reject the hypothesis that respondents consistently prefer more to less when it comes to wildlife population.

Hypothesis H2 claims that existence value concern is the dominant driver for WTP, with major implications for WTP patterns. We find that segment 1 conforms to H2. Thus, we cannot reject the hypothesis that for this segment existence values are the main reason for supporting biodiversity, and they contribute only in so far as securing survival. All other segments have significant WTP for increasing some populations well above survival thresholds, and thus H2 cannot find support as the sole driver of WTP in these segments.

Our formulation of the hypothesis H3, claiming warm glow to be a dominant driver in WTP, also had quite strong implications for WTP relations across population increases, cf. Eqs. 3 and 5. H3 can be rejected for all segments, as there are significant differences in WTP across provision levels for both wildlife attributes in segment 3 and for general wildlife in segment 4. For segment 1 and 2 it is rejected as WTP for some levels is zero. Thus, while we cannot reject that the warm glow of contributing to the 'good cause of wildlife protection' is a strong driving factor in WTP, it appears an insufficient explanation. Finally, under the H3 it would appear that the warm glow for doing something for 'Endangered' is in several segments significantly higher than for 'General wildlife'.

A final comment is needed on the small (8%) segment 2. Note from Table 3 that for this group the price parameter is unusually low, and looking at the WTP estimates we find that this group mainly trade against restrictions in access, to which they strongly oppose. There is, however, also a significant WTP for 'General wildlife +25%', but not for other wildlife attributes. This does not conform to any of our hypotheses, but may indicate that this small group is mainly driven by use concerns, but also do not pay much attention to the payment issue.

Discussion

When biodiversity valuation studies routinely address respondents' WTP for biodiversity in the form of securing species survival, respondents are faced with a question which it would in most socio-cultural contexts appear ethically challenging to negate. And indeed, the literature finds rather significant WTP measures, and also that people's stated WTP in general increases with, e.g. the number of species saved (Czajkowski et al. 2009; Horne et al. 2005; Jacobsen et al. 2008).

However, real conservation policies frequently target much broader enhancements in wildlife population levels, and this study addressed the question if similar straightforward results will be found when we ask people to express their WTP for population levels above those needed for securing survival. To investigate, we designed a CE asking respondents to trade off money against restrictions in access for improving population levels of endangered wildlife as well as general wildlife in three different habitats.

Increasing WTP with increasing scope of good?

The first thing we note about the Latent Class based results is that for none of the segments did we find support for the hypothesis that people will always be willing to pay more, the higher population increases are offered. Thus, the usually expected scope sensitivity (Giraud et al. 1999) is absent. Interestingly, the WTP measures, or rather the willingness to accept (WTA) measures, for access are much better in accordance with usual scope sensitivity assumptions. The access attribute levels were all reductions in access and, as expected, WTP for these were therefore negative. For several segments we found that the stronger the restrictions, the higher the loss in utility.

In analyses not shown here, we analysed if respondents stating that wildlife was important to their recreation experience had a tendency to belong to particular segments. We found that they had a lower probability of being in any of segments 1–3 relative to segment 4. Thus, for a major part of the population at least, use values seem mainly irrelevant to the stated WTP measures for wildlife population increases.

Are existence values the sole driving factor for any groups?

While existence values have been sometimes disputed (Alred 1994; Fredman 1995), there is clear evidence of their role in valuation studies (e.g. Fredman 1995; Jacobsen et al. 2008) and attitudinal studies (Karlsson and Sjöström 2008). If existence value is the main motivation for WTP, implications are rather restrictive, see H2 Eqs. 3 and 4. However, respondents in segment 1 seem to care little for population increase above that needed to secure survival and hence existence values. Thus, this segment has WTP patterns consistent with *H2* and existence per se seems to be what matters to these respondents. In analyses not shown, this was the only segment which differed in socio-economic characteristics from the rest—namely by being older and with lower education and income. This segment also had a larger likelihood of stating that they did not consider all attributes when asked posterior to attribute non-attendance.

For the segments 3 and 4, we find significant WTP for population levels above that needed for survival. Thus, while existence values may still play a role for these respondents, they cannot fully explain results.

In results not shown, it was found that relative to segment 4, respondents stating importance of wildlife for recreational experiences had a much lower probability of being members of these segments. This further supports that use values of wildlife matter little to this group.

Is warm glow potentially a dominant driver for some groups?

We derived rather strict implications for WTP for wildlife from the warm glow hypothesis as formulated in H3. For segments 3 and 4 we find significant differences between population levels of at least one attribute in each segment. Thus, while warm glow may be important for respondents in these groups, the revealed pattern implies that it cannot fully explain results. Also for segment 1 and 2 it cannot explain the pattern observed, where WTP is close to zero for several attributes. Our results here suggest that warm glow could for a part of the population be a major driver for WTP for population increases above survival levels. However, for other parts of the population it is insufficient to explain observed patterns. In that way, this study adds new evidence to a question so far mainly addressed in the contingent valuation literature (Chilton and Hutchinson 2000; Cooper et al. 2004; Nunes and Schokkaert 2003).

We further note that respondents who agree to statements expressing general support and importance of caring for wildlife had no larger probability of being in any of these segments relative to others. Also note that people stressing the importance of wildlife for their recreational experience have a higher probability of being in segment 4.

A need for a fourth hypothesis?

Several of the segments were characterised by a pattern where WTP was higher for moderate than for larger population increases—a pattern visible for both endangered and common wildlife. It is not clear what motivates this pattern, and analyses using responses to various attitudinal and socio-demographic questions did not disclose further information on this. We briefly discuss possible causes for the observed pattern.

If respondents prefer species richness, as suggested for plant diversity in Lindemann-Matthies et al. (2010), large population size might be seen as an impediment to this. Looking into the literature on people's motivations for supporting public goods, we find that the pattern may be motivated by civic preferences or self-image, as described by Nyborg (2000) and Brekke et al. (2003). The interpretation would be that respondents feel a need to do something, as citizens, but also not to exaggerate efforts on one public good, e.g. out of concern for social constraints.

Alternatively, the pattern could reflect an overall unease with increasing wildlife populations, e.g. fear or inconvenience in relation to recreational use. If so, it is likely to be more pronounced for general than for endangered species as is indeed found. However, in a split not presented here, where the general wildlife was presented in more broad terms, we found very similar results.[4] And furthermore, evidence collected in a parallel study (Kanstrup et al. 2009) showed that people do not find the type of species here of any concern for, e.g. recreational activities.

Finally, it could reflect a correction for provision probability (Powe and Bateman 2004). More precisely, it could reflect people's disbelief in the likelihood of the larger attribute levels being achieved, and if they assign a lower probability of provision, we could see reduced WTP (see Wielgus et al. 2009). It is, however, not clear from this why WTP should fall below that of lower attribute levels. Alternatively, people may assess that efforts aimed at high increases in population would be disproportionately costly, and hence they could assign an extra cost to these alternatives. This could drive the estimated WTP of high levels below those of lower. While we cannot rule out these explanations, it was not expressed in any way at the initial focus group meetings.

Caveats and perspectives

While this study has indicated that use values may not be central to people's WTP for efforts to increase wildlife populations, and also that existence values as well as warm glow could be more important, we are still left with numerous questions of what is the deeper nature of these motivations. Our study has only begun to investigate this. Thus, its results raise some new questions. This is particularly true for the segment revealing a kinked WTP with scope. We note that this has been found before in related studies, e.g. Adamowicz et al. (1998).

It would be of interest to identify and investigate in more detail the possible types of moral motivations that may drive the patterns documented here. Much like the efforts made to identify warm-glow effects in CV studies (Chilton and Hutchinson 2000; Cooper et al. 2004; Nunes and Schokkaert 2003). Separating the WTP effect arising from moral

[4] See Footnote 3.

motivations of conserving wildlife and the warm glow of giving will be a difficult task and is beyond this paper. In the theoretical work of both Andreoni (1990) and Brekke et al. (2003), the moral motivation is an argument in the utility function and hence as valid as the utility from consumption of tangible goods. It is outside the scope of the paper to pursue this discussion, but it is important to point out that this kind of values may be even more controversial than the existence value of species, which is also contended as a valid economic value, cf. Krutilla and Fisher (1975); Alred (1994), and Mitchell and Carson (1989).[5]

It is worthwhile to make a comment relating our findings here to the conservation planning literature. In much of this literature, focus has been exclusively on methods and approaches to cover the maximum number of species, or expected coverage in stochastic models for available budgets. See, e.g. Csutia et al. (1997); Polasky et al. (2000, 2008) or Strange et al. (2006) for methodological approaches; recent applications include Jantke and Schneider (2010) and Fiorella et al. (2010). To our knowledge, such studies rarely incorporate measures related to the expected population levels of the different species. The focus on species coverage corresponds to a focus on securing existence and option values first and foremost. Our results here suggest that indeed WTP for securing survival is likely to be much higher than WTP for further population increases. This could be taken as a partial justification for the focus on species coverage in the conservation literature. It should be noted though, that in this as in most valuation studies the provision of the environmental good is framed as a certainty. Thus, if value estimates from studies as are to be used in e.g. cost-benefit evaluations of conservation management programs with uncertain outcomes, the values estimated here needs to be weighted with the probability of actually obtaining the population changes (survival) upon which they are contingent. There could be great policy relevance in integrating more detailed patterns of valuation into conservation models. One such attempt is Strange et al. (2007), again based on species survival values.

Conclusion

Studies addressing the welfare economic value of biodiversity conservation routinely coin the valuation exercise in the form of WTP for securing survival of one or more species. To most people, this is an ethically challenging question to negate, and therefore it is perhaps not surprising that the WTP is often very high in these cases and sensitive to the scope of biodiversity conservation, e.g. the number of species saved. It is a question asked at moral gunpoint.

However, environmental conservation efforts often target more broadly improvements for wildlife and hence increase in wildlife populations also above survival thresholds. The question is how WTP measures will vary with population levels, when we go beyond the morally more challenging level of species survival?

Drawing on the literature on environmental valuation, we formulate several possible hypotheses to answer this question. To investigate empirically, we designed a CE to evaluate WTP for increases in population levels of endangered and general wildlife, including increases beyond survival needs.

[5] Note, however, that one could argue that if the actual provision of the good will in fact not require the actual involvement of the respondents, they may be unlikely to experience the utility effect from improved self-image or warm glow.

A Latent Class analysis of the responses showed that respondents fall into several distinct groups. None of these, however, show consistently higher WTP for higher population levels of wildlife—be it endangered species or wildlife in general. Instead three other groups are identified. The first seems to care little about wildlife, but does express a significant WTP for saving endangered species. This conforms to the hypothesis that existence values dominate WTP for this segment. The second group puts emphasis on wildlife, but with equal weight to moderate and high increases in population for ‘Endangered’ as well as ‘General’ wildlife. Thus, they appear insensitive to scope. While existence values may matter here, they cannot entirely explain the pattern. Rather, the pattern suggests that WTP may be affected by warm glow or deontological motivations. The third and largest group reveal significant WTP, but for at least one of the wildlife attributes, they prefer moderate increases over high. While these people may still hold existence values and be subject to warm glow, these aspects cannot fully explain such a pattern. Potential reasons for such a pattern could be moral motivations or provision cost concerns.

An important practical and policy relevant implication of our results is that when economists frame biodiversity valuation studies in terms of species survival, they are essentially asking respondents to perform a valuation at sort of a moral gunpoint. Therefore, respondents will always express increasing WTP for increasing number of species saved. However, there is a significant difference between asking respondents what they are willing to pay for saving a species, and what they think about increasing the population of a species above the minimum viable population. Thus, estimates from the former kind of analysis should not be used for assessing welfare gains in environmental projects mainly resulting in the latter kind of environmental improvements.

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Appendix

This appendix outlines the information sheet given to respondents. The order in which the habitats were presented varied according to their order in the questionnaire. Two habitats were presented to each respondent. Notice: The questionnaire was in Danish.

Information sheet: wildlife in the Danish nature

Many human activities affect the nature and the wildlife living there. By changing the way we use nature, we can change the conditions for different wildlife species. Depending on which initiatives are taken, different species will be favoured. Some of these species are endangered or declining in number and others are common. In addition, conditions can change so that wildlife experiences become more frequent.

[Habitat 1]

Imagine that we take some initiatives to improve living conditions for wildlife in [habitat 1]. Some initiatives will benefit specific species, while others will benefit wildlife in general.

[Description of wildlife on habitat 1]

[Habitat 2]

Also in [habitat 2] can we take initiatives to improve living conditions for specific species, whereas other initiatives will benefit wildlife in general.

[Description of wildlife on habitat 2]

Encounter of wildlife

Access

Today we are usually allowed to walk and bike on paths and roads in the nature. We can protect wildlife better by prohibiting access to some areas entirely or during the breeding season, which typically is from April to October. This will make wildlife encounters less frequent, but on the other hand wildlife living conditions will improve.

The description of habitats

Lakes and streams

Otter population

The otter is an endangered species in Denmark that lives around and in lakes and streams. We can improve the living conditions for the otter by, e.g. establishing passages for it. Depending on in how many places we take such initiatives, the population may increase somewhat so that the otter becomes rare (but not absolutely endangered) or even common in Denmark.

Great crested grebe population

The great crested grebe is a common breeding bird at Danish lakes. We can improve its living conditions by, e.g. re-establishing lakes and wetlands which have been drained. This will especially benefit the great crested grebe, but also wildlife in general living at lakes and streams. Depending on in how many places we take such initiatives, the population of great crested grebe may increase by 25 or 50%

[Photos of otter and great crested grebe were presented in both splits]

Fields and meadows

Barn owl population

The barn owl is an endangered species in Denmark. It hunts in open fields, bogs and meadows. We can improve the living conditions of the barn owl by, e.g. establishing hedgerows in the open fields. Depending on in how many places we take such initiatives, the population may increase so that the species becomes rare (but not endangered) or even common in Denmark.

Hare population

The hare is a common mammal in fields and meadows in Denmark. Its living conditions can be improved by, e.g. letting parts of fields remain uncultivated and pesticide-free, so that the availability of food and shelter increases. This may especially benefit the hare, but also wildlife in general living on fields and meadows. Depending on in how many places we take such initiatives, the population of hare may increase by 25 or 50%.

[Photos of barn owl and hare were presented in both splits]

Forests

Dormouse population

The dormouse is an endangered species in Denmark. It lives in forests with a dense lower storey. By, e.g. mixing bushes and trees, its living conditions can be improved. Depending on in how many places we take such initiatives, the population of dormouse may increase so that the species becomes rare (but not endangered) or even common in Denmark.

Greater spotted woodpecker population

Greater spotted woodpecker is a common breeding bird in the Danish forests. Its living conditions can be improved by, e.g. leaving dead wood in the forests. This will especially benefit the greater spotted woodpecker, but also other wildlife species living in forests. Depending on in how many places we take such initiatives, the population of greater spotted woodpecker may increase by 25 or 50%.

[Photos of dormouse and greater spotted woodpecker were presented in both splits]

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